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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/823,773	04/14/2004	Takahiro Hamada	023971-0407	4680
22428 7590 10/29/2008 FOLEY AND LARDNER LLP SUITE 500 3000 K STREET NW WASHINGTON, DC 20007				
EXAMINER				
GIMIE, MAHMOUD				
ART UNIT		PAPER NUMBER		
3747				
MAIL DATE		DELIVERY MODE		
10/29/2008		PAPER		

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BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES

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*Ex parte* TAKAHIRO HAMADA, YUTAKA MABUCHI,  
MAKOTO KANO, and YUUJI AZUMA

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Appeal 2008-2351  
Application 10/823,773  
Technology Center 3700

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Decided: October 29, 2008

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Before LINDA E. HORNER, ANTON W. FETTING, and  
MICHAEL W. O'NEILL, *Administrative Patent Judges*.

HORNER, *Administrative Patent Judge*.

DECISION ON APPEAL  
STATEMENT OF THE CASE

Takahiro Hamada et al. (Appellants) seek our review under 35 U.S.C.  
§ 134 of the final rejection of claims 1-7. We have jurisdiction under  
35 U.S.C. § 6(b) (2002).

## SUMMARY OF DECISION

We REVERSE.

## THE INVENTION

The Appellants' claimed invention is to a fuel injection valve including a needle valve coated with a hard carbon thin film (Spec. 1:5-9). In particular, the surface roughness of the hard carbon thin film is controlled in accordance with surface hardness and the film thickness to prevent the film from cracking and peeling (Spec. 15: 6-12). Claim 1, reproduced below, is the sole independent claim and is representative of the subject matter on appeal.

1. A fuel injection valve comprising:  
a needle valve including a base material;  
an opposite member including a base material whose sliding section is in slidable contact with a sliding section of the base material of the needle valve in presence of fuel for an automotive vehicle; and  
a hard carbon thin film coated on at least one of the sliding sections of the base materials of the needle valve and the opposite member, the hard carbon thin film having a surface hardness ranging from 1500 to 4500 kg/mm<sup>2</sup> in Knoop hardness, a film thickness ranging from 0.3 to 2.0  $\mu\text{m}$ , and a surface roughness ( $R_y$ ) ( $\mu\text{m}$ ) which satisfies a relationship represented by the following formula (A):

$$R_y < (0.75 - Hk/8000) \times h + 0.0875 \dots (A)$$

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where  $h$  is the thickness ( $\mu\text{m}$ ) of the hard carbon thin film; and  $H_k$  is the surface hardness in Knoop hardness ( $\text{kg/mm}^2$ ) of the hard carbon thin film.

### THE REJECTIONS

The Examiner relies upon the following as evidence of unpatentability:

Coffinberry	US 6,156,439	Dec. 5, 2000
Haji	US 6,514,298 B2	Feb. 4, 2003
Dam	US 6,715,693 B1	Apr. 6, 2004

The following rejections are before us for review:

1. Claim 1 is rejected under 35 U.S.C. § 103(a) as unpatentable over Dam.
2. Claims 2-7 are rejected under 35 U.S.C. § 103(a) as unpatentable over Dam and Haji.
3. Claim 1 is rejected under 35 U.S.C. § 103(a) as unpatentable over Coffinberry.
4. Claims 2-7 are rejected under 35 U.S.C. § 103(a) as unpatentable over Coffinberry and Haji.

### ISSUES

The first issue before us is whether the Appellants have shown the Examiner erred in determining that it would have been obvious to operate the thin film coated fuel injector of Dam with a surface roughness value below the maximum value of roughness specified by the formula of claim 1

in view of Dam's disclosure of hardness and film thickness values and its suggestion of a desirability of a smooth contact surface.

The second issue before us is whether the Appellants have shown the Examiner erred in determining that it would have been obvious, in view of Coffinberry's teaching of a surface layer having a hardness of greater than  $200 \text{ kg/mm}^2$ , to optimize the surface hardness to a value that falls within the range of values predicted by the formula of claim 1.

#### FINDINGS OF FACT

We find that the following enumerated findings are supported by at least a preponderance of the evidence. *Ethicon, Inc. v. Quigg*, 849 F.2d 1422, 1427 (Fed. Cir. 1988) (explaining the general evidentiary standard for proceedings before the Office).

1. Dam discloses a fuel injector 14 having a needle valve member 86 comprising a low alloy or tool grade steel substrate 95 and a primary thin film coating 96 containing diamond like carbon (Dam, col. 2, ll. 41-53, col. 3, ll. 22-25, col. 4, ll. 36-42 and 51-56).
2. The coating has a thickness no greater than about 2.0 microns and preferably of between about 0.5 microns and about 1.7 microns (Dam, col. 2, ll. 53-54, col. 5, ll. 11-14).
3. Dam discloses that the hardness of the metal carbon material coating is greater than  $1000 \text{ Kg/mm}^2$  in Knoop hardness (Dam, col. 2, ll. 61-64, col. 6, ll. 8-9).

4. Dam does not teach a surface roughness ( $R_y$ ) that satisfies the relationship of  $R_y < (0.75 - H_k/8000) \times h + 0.0875$ .
5. Coffinberry discloses a wall 12 of a fluid containment article 10, including fuel injector surfaces, having a coating 14 to reduce or prevent the formation and adhesion of gum and coke depositions from the fuel on the wall 12 (Coffinberry, col. 4, ll. 56-65 and col. 5, ll. 13-17).
6. Coffinberry discloses that a preferred surface roughness for coating 14 is about 4 micrometers or less (Coffinberry, col. 5, ll. 32-34).
7. Coffinberry discloses, with reference to a first embodiment having a metal or metal-metal surface layer 18, that the thickness of the layer 18 is at least about 0.5 micrometers (Coffinberry, col. 6, ll. 53-56).
8. Coffinberry, with reference to a second embodiment, discloses that layer 18 of coating 14 can contain carbon in a “diamond-like” state (Coffinberry, col. 7, l. 3).
9. Coffinberry does not disclose a preferred thickness for the carbon layer 18 of its second embodiment.
10. Coffinberry teaches that a preferred diamond-like material for carbon layer 18 is one used for its hardness, such as a material produced by Diamonex, Inc. having a hardness greater than 200 kg/mm<sup>2</sup> (Coffinberry, col. 7, ll. 11-16; see also U.S. Patent No. 5,508,092, col. 4, ll. 17-19, incorporated by reference in Coffinberry).

## PRINCIPLES OF LAW

“Section 103 forbids issuance of a patent when ‘the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.’” *KSR Int’l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1734 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art, (2) any differences between the claimed subject matter and the prior art, (3) the level of skill in the art, and (4) where in evidence, so-called secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). *See also KSR*, 127 S. Ct. at 1734 (“While the sequence of these questions might be reordered in any particular case, the [*Graham*] factors continue to define the inquiry that controls.”)

In rejecting claims under 35 U.S.C. § 103(a), the examiner bears the initial burden of establishing a prima facie case of obviousness. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992); *see also In re Piasecki*, 745 F.2d 1468, 1472 (Fed. Cir. 1984). Only if this initial burden is met does the burden of coming forward with evidence or argument shift to the appellant. *See Oetiker*, 977 F.2d at 1445; *see also Piasecki*, 745 F.2d at 1472. Obviousness is then determined on the basis of the evidence as a whole and the relative persuasiveness of the arguments. *Id.*

## ANALYSIS

### *Rejection of claim 1 under 35 U.S.C. § 103(a) as obvious over Dam*

The Appellants contend that the Examiner erred in rejecting claim 1 as obvious over Dam, because Dam fails to teach or suggest a surface roughness which satisfies the relationship represented by the formula in claim 1 (App. Br. 5). The Appellants contend that the formula of claim 1 was empirically derived as part of the Appellants' research into the interplay between surface roughness, hardness, and thickness (*id.*). Thus, the Appellants argue that knowledge of the values for hardness and thickness does not automatically result in knowledge of the values for surface roughness (App. Br. 6). We agree with the Appellants.

Even though Dam discloses a needle valve coated with a hard carbon, thin film coating having a surface hardness of greater than 1000 kg/mm<sup>2</sup> in Knoop hardness and a thickness of between 0.5 to 1.7 microns, Dam does not teach a surface roughness that satisfies the relationship with surface hardness and thickness as set forth in the formula of claim 1 (Facts 1-4). Further, Dam does not suggest that surface roughness must be below a particular amount based on a relationship with film hardness and thickness as recited by the formula contained in claim 1, and one having ordinary skill in the art would not have reached the claimed relationship of surface roughness to hardness and thickness merely by virtue of the disclosed ranges for hardness and thickness provided in Dam. Thus, we are persuaded that the Examiner erred in rejecting claim 1 as unpatentable over Dam.



*Rejection of claim 1 under 35 U.S.C. § 103(a) as obvious over Coffinberry*

The Appellants likewise contend that the Examiner erred in rejecting claim 1 as obvious over Coffinberry, because Coffinberry fails to teach or suggest a “hard carbon thin film having a surface hardness ranging from 1500 to 4500 kg/mm<sup>2</sup> in Knoop hardness” as recited in claim 1 (App. Br. 10). The Appellants again contend that the formula of claim 1 was empirically derived as part of the Appellants’ research into the interplay between surface roughness, hardness, and thickness (*id.*). Thus, the Appellants argue that the claimed range for surface hardness is not the automatic result of forming a film having a surface roughness and thickness that fall within the claimed formula (*id.*). We again agree with the Appellants.

Although Coffinberry discloses a fuel injector surface coated with a high carbon thin film coating having a particular surface roughness, Coffinberry’s only teaching of the hardness of the coating is that the coating has a hardness greater than 200 kg/mm<sup>2</sup> (Facts 5, 6, & 10), which is well outside the claimed range of 1,500 - 4,500 kg/mm<sup>2</sup> in Knoop hardness. Further, Coffinberry does not disclose a preferred thickness for the high carbon thin film layer (Facts 7-9). Coffinberry also does not suggest that the surface roughness bears any relationship with film hardness and thickness in the manner recited by the formula contained in claim 1, and one having ordinary skill in the art would not have reached through routine optimization the claimed film hardness or the claimed relationship of surface roughness to hardness and thickness merely by virtue of Coffinberry’s disclosure of

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certain ranges for these variables. Thus, we are persuaded that the Examiner erred in rejecting claim 1 as unpatentable over Coffinberry.

*Rejections of claims 2-7 under 35 U.S.C. § 103(a) as unpatentable over Dam or Coffinberry in view of Haji*

The Examiner relied on Haji for the suggestion to add ester-based additives to the fuel (Ans. 5, 7). The Examiner does not explain how one having ordinary skill in the art would have been led to the invention of claim 1, from which claims 2-7 depend, based on Dam or Coffinberry in view of Haji. Thus, the Examiner has failed to set forth a prima facie case of obviousness of claims 2-7.

#### CONCLUSIONS OF LAW

We conclude the Appellants have shown that the Examiner erred in rejecting claim 1 under 35 U.S.C. § 103(a) as unpatentable over Dam or Coffinberry and erred in rejecting claims 2-7 under 35 U.S.C. § 103(a) as unpatentable over Dam or Coffinberry in view of Haji.

#### DECISION

The decision of the Examiner to reject claims 1-7 is reversed.

REVERSED

vsh

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